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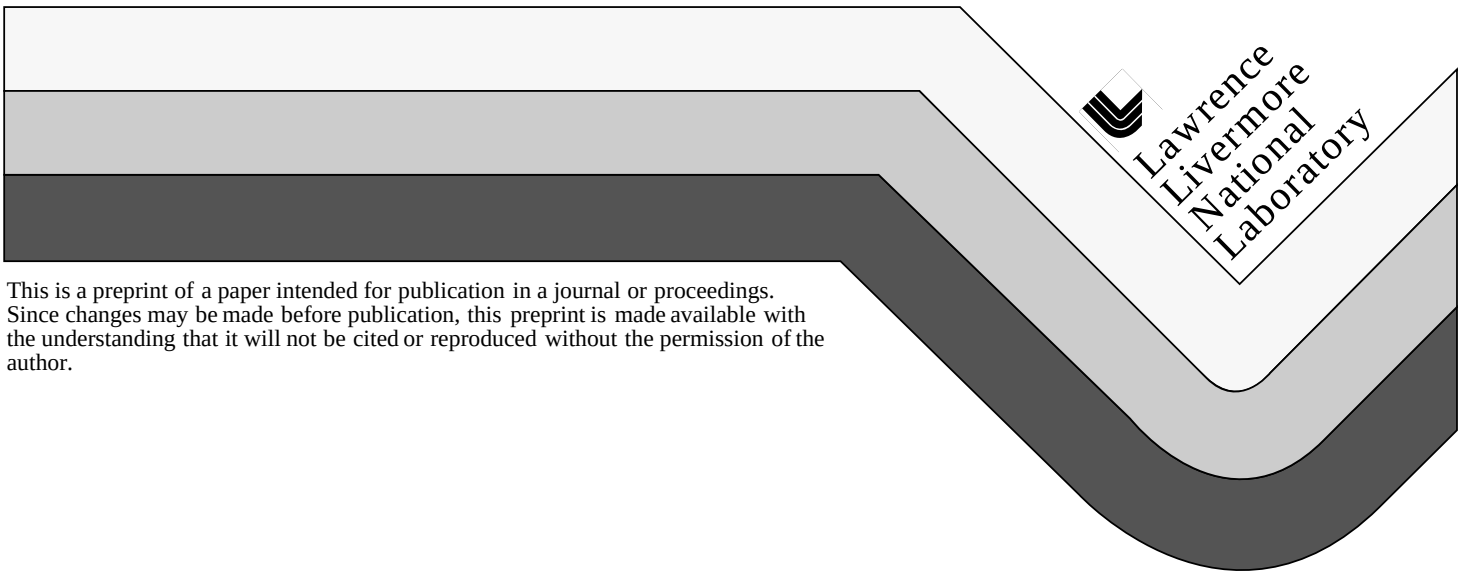

Federal Facilities Compliance Act Waste Management

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Abstract:

Site Treatment Plans (STPs) developed through the Federal Facilities Compliance Act pose many technical and administrative challenges. Legacy wastes managed under these plans require Land Disposal Restriction (LDR) compliance through treatment and ultimate disposal. Although capacity has been defined for most of the Department of Energy wastes, many waste streams require further characterization and many need additional treatment and handling beyond LDR criteria to be able to dispose of the waste. At Lawrence Livermore National Laboratory (LLNL), the Hazardous Waste Management Division has developed a comprehensive Legacy Waste Program. The program directs work to manage low level and mixed wastes to ensure compliance with nuclear facility rules and its STP. This paper provides a survey of work conducted on these wastes at LLNL. They include commercial waste treatment and disposal, diverse forms of characterization, inventory maintenance and reporting, on-site treatment, and treatability studies. These activities are conducted in an integrated fashion to meet schedules defined in the STP. The processes managing wastes are dynamic due to required integration of administrative, regulatory, and technical concerns spanning the gamut to insure safe proper disposal.

About Lawrence Livermore Laboratory:

LLNL (Lawrence Livermore National Laboratory) is owned by the DOE (Department of Energy) and is jointly operated by the University of California and the DOE. The Laboratory was established in 1952 to conduct nuclear weapons research. Since 1952, other major programs including magnetic fusion energy, laser fusion and laser isotope separation, biomedical and environmental sciences, and applied energy technology have been conducted.

LLNL's main site is located approximately 40 miles east of San Francisco, California, at the southeast end of the Livermore Valley in southern Alameda County, adjacent to the City of Livermore.

Much of LLNL's materials testing and high explosives work is conducted at Site 300. Site 300 is located in the sparsely populated hills of the Diablo Range, 15 miles southeast of the Livermore main site.

Mixed waste management operations at LLNL are subject directly or indirectly to federal, state,

regional, and local environmental laws and regulations. Waste operations at LLNL include the safe and proper handling, treatment, packaging, storage, and disposition of all hazardous and mixed wastes generated by LLNL. Mixed wastes can be treated only at the Livermore main site. Existing treatment for mixed wastes includes neutralization, flocculation, chemical reduction and oxidation, precipitation, separation, filtration, solidification, size reduction, shredding, adsorption, blending, centrifugation, and evaporation. LLNL has shipped mixed waste for treatment and disposal to Envirocare, and primarily ships treated waste residue, no longer mixed, to the Nevada Test Site for disposal.

The Hazardous Waste Management Division (HWMD) of LLNL's Environmental Protection Department (EPD) manages all mixed wastes generated at LLNL. HWMD processes these wastes for temporary storage, treatment, and transportation for recycling or off-site disposal. HWMD also processes, stores, packages, solidifies, treats, or prepares waste for shipment and disposal, recycling, or discharge to the sanitary sewer.

The Federal Facilities Compliance Act:

The Federal Facility Compliance Act, signed on October 6, 1992, waives sovereign immunity for fines and penalties for RCRA violations at federal facilities. However, a provision postpones that waiver for three years for mixed waste LDR (Land Disposal Restriction) storage prohibition violations at DOE sites and requires DOE to prepare plans for developing the required treatment capacity for mixed waste. Each plan must be approved by the state or EPA, after consultation with other affected states and consideration of public comment, and an order issued by the regulator requiring compliance with the plan. The Act further provides that DOE will not be subject to fines and penalties for LDR storage prohibition violations for mixed waste as long as it complies with an approved plan and order.

The Act specifies that the STPs must address all mixed wastes at the site, regardless of the time of generation. For mixed waste for which identified treatment technologies exist, the plan must provide a schedule and milestones for constructing the necessary treatment capacity. For mixed waste without an identified existing treatment technology, the plan must include a schedule for identifying and developing technologies.

A mixed waste inventory report is also required by the Act. This report provides an inventory of all mixed wastes stored, generated and projected over the next five years, at each DOE site, and an inventory of treatment capacities and technologies. An interim report was published by DOE in April 1993 and subsequent reports have been published at least annually thereafter.

The "Schedule for Submitting Plans for the Treatment of Mixed Waste Generated or Stored at Each Site", as required by the Act, was published April 6, 1993, in the Federal Register (58 FR 17875). The published schedule specifies that DOE sites will provide the site treatment plans in three phases, the "conceptual plan" by October 1993, a "draft plan" no later than August 1994, and a "final proposed plan" no later than February 1995.

DOE arrived at this tiered approach to preparing the STPs based on discussions with the states, EPA, and other interested parties. The process provided opportunity for early involvement by the states and others in the decision-making process. Most importantly, the CSTP and the draft plan provided an early opportunity for discussions on technical and equity issues between the site and the regulatory agency and among affected states, the EPA, and other parties. The interim

plans provided a base of information about each site's waste, the technology needs, existing and planned treatment facilities, and treatment options, including potential options for treating off-site wastes, to facilitate these discussions.

Lawrence Livermore Laboratories Approach:

The Government Owned Contract Operated site, LLNL, has been involved in the STP process since its inception. LLNL has produced the conceptual STP for DOE and participated in negotiations with the California DTSC (Department of Toxic Substances Control) for approval of our first Site Treatment Plan in February 1997. Since then, LLNL has provided several updates of the plan. The current plan proposes a mixture of on-site treatment and off-site treatment and disposal at commercial and DOE owned facilities.

The present LLNL STP contains elements including waste categorization, schedules for treatment, and locations for treatment (sometimes primary and secondary locations). LLNL's plan does not include provisions for defining wastes needing further characterization, but this approach to many wastes is often used due to discrepancies in past waste characterization. The plan must be updated to demonstrate a change in treatment due to re-characterization.

The STP for LLNL requires treatment to meet LDRs for low level mixed wastes promulgated by EPA. Because of the varied categorization of wastes and the many different waste streams at LLNL, there are several locations designated. Once treated to meet LDRs, wastes are no longer managed under the FFCAct. In many instances, commercial facilities have treated the waste and disposed of the residue at their site. Many DOE sites have proposed this as well.

During our implementation of DOE's STP for LLNL, some issues have surfaced regarding waste characterization and site acceptance. Legacy waste, wastes that have been placed into storage for long periods of time due to the lack of national treatment capacity, have often been characterized by generator knowledge without the additional information that is needed in present-day waste management. The characterization for chemical and radiological constituents has broadened through the promulgation of "hard hammers" with EPA and specific licensing requirements for the NRC. In addition, radioassay and chemical analysis methods have improved bringing into question past characterization practices. In addition, when questions arise, specific waste generators are not available because they have left the laboratory. Often whole programs have changed and cannot shed light on past practices.

Because of the long waste storage and the issues described above, LLNL has had some difficulties meeting proposed schedules for treatment under the STP. Recent changes such as DOE's Integrated Safety Management, and promulgation of DOE rates under the Price Anderson Amendments Act, has caused due diligence in examining current waste management practices for low level mixed waste operations at LLNL. In addition, the relatively small amount of waste stockpiled, along with the diverse waste types generated in LLNL's research charter, complicates FFCAct compliance. LLNL is not considered a major customer when compared to other sites having larger, more consistent waste streams for commercial profit centers.

On balance, LLNL has put together a multifaceted project run by the Legacy Waste Program, an administrative office in the Hazardous Waste Management Division of LLNL. This program has had several successes in implementing STP requirements, but there are several lessons learned as well. The program runs activities including diverse forms of characterization, obtaining

commercial waste treatment and disposal, inventory maintenance and reporting, on-site treatment, and treatability studies. Present waste streams at LLNL are included in the table 1.

Table 1. LLNL present Waste Streams:

Waste Stream Number	Waste Stream Description	Method of FFCAct Compliance*
LL-W001	Lab packs without metals	ORNL K-25, incinerator
LL-W002	Inorganic sludges/particulates	On-site treatment, stabilization, or Envirocare
LL-W003	Inorganic debris	INEEL, thermal treatment, or Envirocare
LL-W004	Aqueous liquid	On-site treatment, waste water process
LL-W005	Inorganic sludges/particulates	On-site treatment, stabilization
LL-W006	Inorganic debris	INEEL, thermal treatment, or Envirocare
LL-W007	Elemental lead (bricks)	INEEL, macroencapsulation, or Envirocare
LL-W008	Organic liquids	ORNL K-25, incinerator
LL-W009	Organic liquids	ORNL K-25, incinerator
LL-W010	Soils	On-site treatment, stabilization, or Envirocare
LL-W011	Reactive metals	On-site treatment, small-scale
LL-W014	Organic liquids	ORNL K-25, incinerator
LL-W015	Inorganic debris	INEEL, stabilization
LL-W016	Organic liquids	ORNL K-25, incinerator
LL-W017	Heterogeneous debris	INEEL, thermal treatment
LL-W021	Labpacks with metals	INEEL, thermal treatment
LL-W022	Depleted uranium chips with coolant	On-site treatment, small-scale
LL-W023	Soils with debris	On-site treatment, stabilization
LL-W024	Liquid mercury	INEEL, amalgamation
LL-W025	Cemented solids	On-site treatment, stabilization, or Envirocare, or ORNL K-25, incinerator
LL-W026	Organic sludges/particulates	ORNL K-25, incinerator
LL-W027	Other reactives	On-site treatment, small-scale

* On-site treatment will be conducted at LLNL with existing treatment operations or in facilities being built under an approved RCRA permit. ORNL stands for Oak Ridge National Laboratory and INEEL Idaho Environmental and Engineering Laboratory. Envirocare is a commercial treatment and disposal facility

Characterization:

Waste stream numbers were assigned at LLNL very generically. In many instances, waste within each waste stream number or category must be opened, visually examined, and sampled for chemical and radiological analysis. Analysis is often needed by commercial disposal sites, such as Envirocare. We must take representative samples from heterogeneous wastes such as for inorganic debris (LL-W005, LL-W006, LL-W015), spending thousands of dollars to have standard EPA method testing performed at state certified laboratories.

Samples were taken from the organic liquid streams to meet the needs of the ORNL K-25 incinerator. LLNL spent over $100,000 in sampling this waste stream. It is possible that these wastes will not be processed at the ORNL K-25 incinerator, due to equity issues raised by the state of Tennessee.

A lot of good characterization has been performed on drums of waste using real-time radiography, gamma spectroscopy, and passive neutron counting. There has also been some limited success with computer-aided tomography. These assay techniques continue to improve in sensor sensitivity, ease of use, availability, and computer analysis. These techniques do not help determine compliance with land disposal criteria but are indispensable in determining debris morphology and radioisotope constituents. Gamma spectroscopy coupled with passive neutron counting has been accepted for NRC license and DOE disposal criteria and more importantly to determine radiation safety for drum opening and repackaging requirements for legacy waste. Radiography also helps determine what is in a waste drum. This has proven helpful to stimulate the memories of waste generators, give technicians a plan of attack guide for re-packaging, and has verified non-compliance with disposal site criteria due to finding free liquids and lead package seals.

Good characterization has been extremely important especially for legacy waste. On July 2, 1997, LLNL had an incident that resulted in unacceptable personnel contamination. Personnel were shredding what they thought to be building ventilation filters. During processing, they unknowingly shredded a glove box housekeeper HEPA filter. The resulting incident was the largest Price Anderson Amendments Act violation of its time. There were many contributing factors resulting in this incident, not the least of which was mischaracterization. LLNL has developed a radioassay unit that will screen the HEPA filters. The screening process will be used to further characterize the radiological content and to determine where destructive sampling can be performed (e.g., tent, hood, glovebox). After destructive sampling, LLNL will have sufficient information to develop profiles for treatment and disposal.

LLNL routinely samples legacy wastes that fall under the Federal Facilities Compliance Act successfully. Waste for on-site treatment, residues from treatment, and soils have all been characterized with great accuracy. In FY97, LLNL repackaged 870 drums of diatomaceous earth into forty 100 cubic foot boxes. Samples were taken from each box and the results were compared to Envirocare's WAC. The waste stream was contaminated with a variety of organics and metals in varying concentrations. A profile was approved and 37 of the boxes were shipped to Envirocare for stabilization and disposal.

Commercial Waste Treatment and Disposal:

LLNL continues to pursue on-site treatment as a preferred option whenever possible. In addition to on-site treatment, LLNL is actively trying to develop relationships with commercial vendors. Currently, LLNL has shipped mixed waste to Envirocare of Utah, Permafix of Florida, and Diversified Scientific Services Incorporated (DSSI). LLNL has prepared five profiles with Envirocare, including two profiles for stabilization and disposal of diatomaceous earth, stabilization and disposal of shredded HEPA filters, macroencapsulation and disposal of lead, and direct disposal of "F-listed" soil. Contaminated oils were sent to DSSI for burning in their industrial boiler. Mixed waste scintillation vials are currently being shipped to Permafix for pre-processing then these liquids will be shipped to DSSI for burning.

LLNL is pursuing profiles for the burning of ignitable liquids with DSSI and the burning of chlorinated liquids at the DOE owned incinerator located in the East Tennessee Technology Park.

Inventory Maintenance and Reporting:

The STP plan requires three major reports to be submitted to the state on an annual basis. These are a milestone report, an annual report, and a semi-annual report. The annual and semi-annual reports provide the state with information to track progress on milestones and target dates. These reports bring the status of the STP up-to-date. The milestone report is used to propose new milestones and target dates for waste received the previous fiscal year and to propose changes to existing milestones and target dates. The STP also requires the state to be notified within 30 days of completing any milestone and must be notified a minimum of 30 days prior to using a treatment option other than the one(s) specified in the STP. If a milestone cannot be met within the required time, a milestone extension request explaining the problem is submitted to the State. This extension request must be submitted as early as possible, but no later than 30 days prior to the milestone date. LLNL has submitted changes to milestones occasionally using these notifications.

Detailed inventories of all the containers associated with each waste stream are maintained. In addition, the time-line for each container is tracked within its associated waste stream. This tracking is the basis for the development of the milestone updates. The inventories are used to track the progress and to develop the information needed for the various reports, notices, and certifications that are required to be submitted to the state. With thousands of containers in the inventory, a major problem in managing the FFCAct STP is balancing the inventories while tracking volumes to 0.01 cubic meters. Many containers are less than or equal to five gallons (≈ 0.02 cubic meters). A one-gallon container is approximately 0.004 cubic meters. As old waste is treated or repackaged, new waste is accepted and the volume in storage is constantly changing.

On-site Treatment:

LLNL performs several treatment activities on-site as mentioned earlier. The primary treatment method used for FFCAct waste treatment is standard industrial wastewater type treatment and stabilization. It is these two treatments either separately or combined that allow LLNL to meet LDRs, and thus comply with the STP. To date, LLNL has never missed an on-site treatment FFCAct milestone. The industrial wastewater treatment LLNL uses is a batch process where the waste is fed to 1850-gallon tanks. LLNL uses Fenton's reagent (hydrogen peroxide and iron ion couple) with great success in removing small amounts of organic constituents by chemical oxidation. Metals are removed by hydroxide precipitation. The method used is a simple one. Metals are brought to the highest oxidation-state by using hydrogen peroxide catalyzed with sulfuric acid. Ferric sulfate is then added to destabilize charge and flocculate the precipitate once formed. The hydroxide precipitate is formed by adding sodium hydroxide to achieve a moderately high hydroxyl ion content (pH is about 9).

Once the floc has been formed, it is filtered using a rotary-drum vacuum filter. The filter cake is composed of diatomaceous earth and tapwater. The water is stored, sampled, and analyzed. If the water meets the sanitary sewer's Clean Water Act permit condition, it is released. If it does not meet the criteria, it is re-treated until it does.

Stabilization is performed on the contaminated diatomaceous earth, now laden with metals. Stabilization is also performed on other wastes such as soils, resins, and machine cuttings. Wastes amenable for stabilization at LLNL are process solids, somewhat uniform in size (biggest piece less than a half an inch) that have less than six parts per million volatile organics and are

laden with regulated metals. Stabilization is performed in a change can-type mixer using two open paddle mixers that move in a double planetary motion. The media used to stabilize wastes are proprietary magnesium-aluminum silicates. Occasionally, sodium dithiocarbamate is added as a pH insensitive additive to lock in the metals. This process has proven to pass TCLP and has been used to stabilize hundreds of drums.

Treatability Studies:

Treatability studies are often required to determine the best method to treat a waste. The goal of a treatability study is to determine if a waste can be treated to meet LDRs or to meet a commercial site's waste acceptance criteria. Once a treatability study is conducted successfully, the waste can be treated using existing processes or a permit modification can be requested to treat the rest of the waste. Several treatability studies have been conducted since the FFCAct was promulgated. The vast majority of treatability studies conducted pertain to stabilization development. Recipes have been developed through treatability studies to effectively make liquid or soupy sludges into solids for the Nevada Test Site that allows only a half percent by volume free liquid. More importantly, recipes have been developed to prevent metals from leaching from a waste stabilization matrix. Through treatability study experience, we have gained in recipe development that has allowed LLNL the confidence to use a standard recipe often forgoing further study. This has saved LLNL time and money and produced stabilized waste on a full scale that has met both commercial (Envirocare) and DOE (Nevada Test Site) waste disposal criteria. Once metals are stabilized, since they contribute to only "characteristic" waste, they can be disposed of as non-hazardous at industrial NRC landfills.

Treatability studies are often conducted on wastes containing volatile organic compounds greater than six parts per million. These wastes, if "F-listed", require removal or destruction of the organic compounds to meet LDRs and to be able to dispose of them at a "class C" landfill. To date, these wastes are LLNLs most challenging types of wastes. Presently, the national capacity is limited and is all thermal treatment. It also has been difficult to get wastes to these thermal treatment facilities such as INEEL's thermal treatment plant or ORNL's K-25 incinerator. Presently, INEEL's thermal treatment plant is not open to accept LLNL's waste and the ORNL's K-25 incinerator is presently closed. Additionally, Envirocare refused to take LLNL's waste stream because it caused thermal excursion in their oxidation step as pretreatment to stabilization. For these reasons, LLNL has embarked on treatability studies of these wastes.

Presently, LLNL has conducted treatability studies on diatomaceous earth laden with over a thousand parts per million volatile organics, mostly methyl chloroform. Samples of this waste are used to test various oxidation methods in a controlled environment. Mostly traditional oxidants have been used such as persulfate and permanganate salts and hydrogen peroxide. LLNL will also test oxone and iron catalyzed hydrogen peroxide (Fenton's Reagent) but potassium permanganate so far, shows the most promise. LLNL has also performed treatability studies on liquid wastes containing almost pure methyl chloroform contaminated with uranium.

This study used hydrolysis in a pressure cooker followed by sodium persulfate oxidation at elevated temperatures. The methyl chloroform was destroyed but not without health and safety issues and a large amount of secondary waste.

LLNL also has scheduled treatability studies on cyanide laden wastes, elemental mercury contaminated with tritium, methanol wastes containing about a hundred curies of tritium, and alkali metal hydrides contaminated with over fifty curies tritium. Many of these wastes are not allowed anywhere commercially due to their high reactivity or high tritium content. Two of these studies are scheduled to conclude before October of this year. Others are scheduled for next year.

Final Notes:

LLNL has received a permit to perform small-scale treatment in a new facility called the Decontamination and Waste Treatment Facility. This permit will allow LLNL to get rid of small, difficult wastes through methods used in treatability studies without needing a permit modification. This will go a long way toward keeping LLNL in compliance with the Federal Facilities Compliance Act.

LLNL's proposed STP contained 23 different waste streams. It was submitted to DTSC by DOE on March 31, 1995. The plan was approved by DTSC in February 1997. On March 31, 1995, LLNL had 671 cubic meters of mixed waste in storage. As of September 1, 1998 LLNL had added 286 cubic meters and treated approximately 355 cubic meters leaving a current inventory of approximately 602 cubic meters.

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